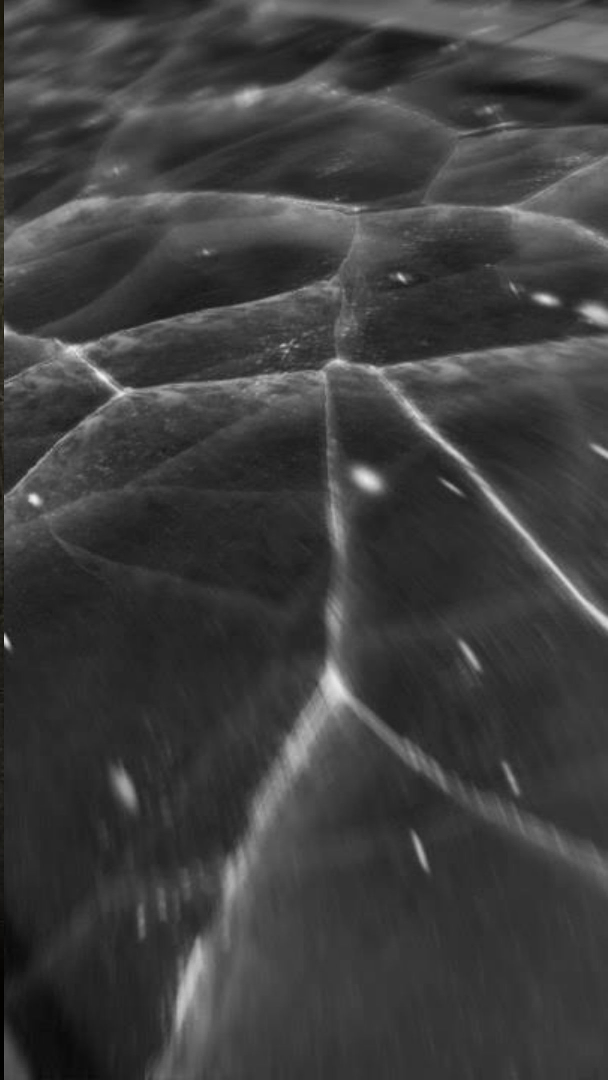
GeomCaches for VFX in Ryse

Sascha Herfort

Senior Technical Artist

GeomCaches in Ryse

I. Introduction
II. Why GeomCaches?
III. Features & Limitations
IV. Pipeline Development
V. Case Studies
VI. Conclusion



GeomCaches

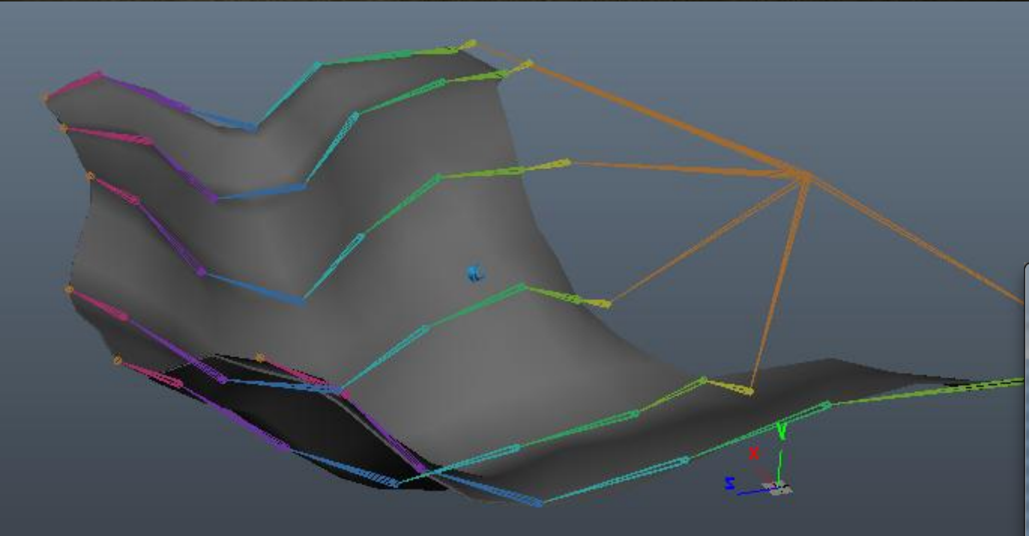
- aka Alembic Caches
- aka *“VFX Setpieces”*
- aka *“this is why we CAN have nice things”*

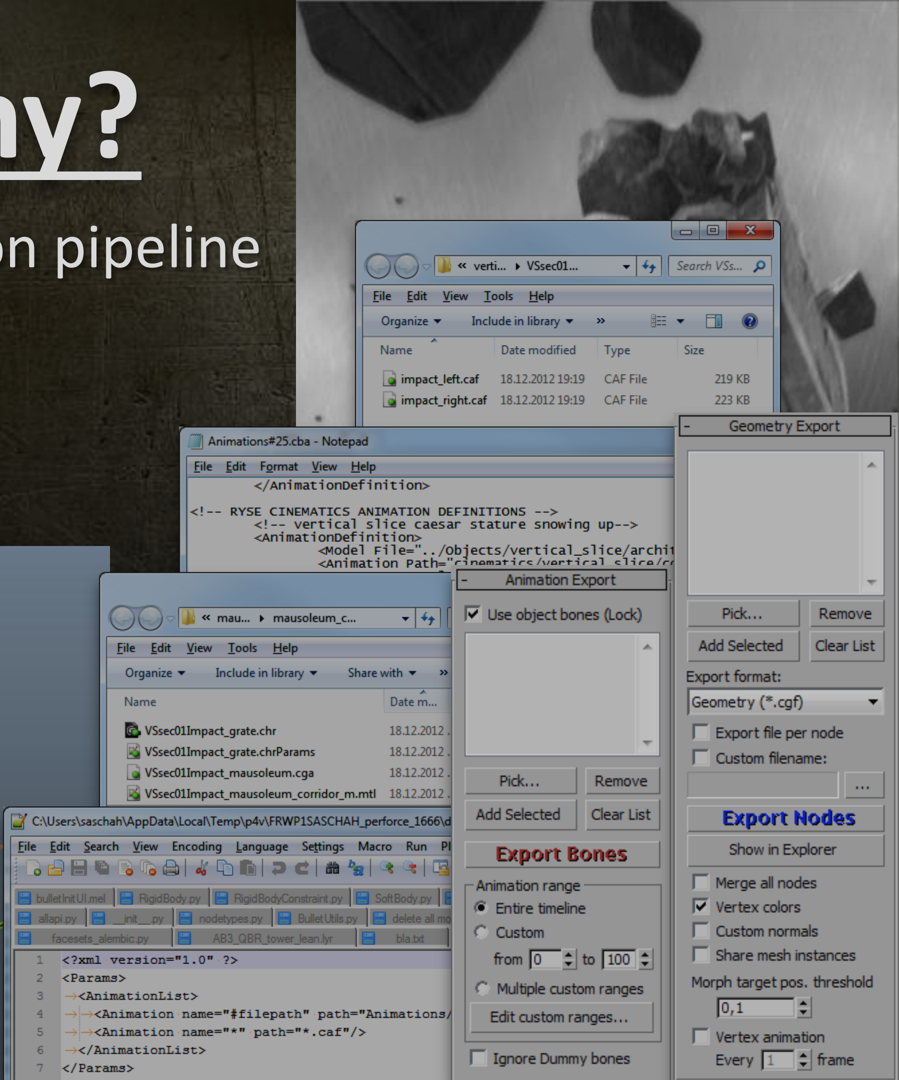
- Crytek’s real-time geometry cache pipeline
- Used for:
  - Cinematic Setpieces
  - Animated Props in-game
  - Interactive Objects in-game
  - anything with many moving parts that isn’t a character
- [Video 01]

Why GeomCaches?

GeomCaches – Why?

- Previously used character animation pipeline
  - Cumbersome (bake to joints)
  - Error-prone (manual XML setup)
  - Inefficient to render (runtime skinning)





« verti... ▸ VSsec01...
Search VSs...
File Edit View Tools Help
Organize ▾ Include in library ▾ »

Name	Date modified	Type	Size
impact_left.caf	18.12.2012 19:19	CAF File	219 KB
impact_right.caf	18.12.2012 19:19	CAF File	223 KB

Animations#25.cba - Notepad

File Edit Format View Help

```
        </AnimationDefinition>

<!-- RYSE CINEMATICS ANIMATION DEFINITIONS -->
        <!-- vertical slice caesar stature snowing up-->
        <AnimationDefinition>
                <Model File="../objects/vertical_slice/archit
                <Animation Path="cinematics/vertical_slice/c
```

« mau... ▸ mausoleum_c...
File Edit View Tools Help
Organize ▾ Include in library ▾ Share with ▾ »

Name	Date m...
VSsec01Impact_grate.chr	18.12.2012
VSsec01Impact_grate.chrParams	18.12.2012
VSsec01Impact_mausoleum.cga	18.12.2012
VSsec01Impact_mausoleum_corridor_m.mtl	18.12.2012

C:\Users\saschah\AppData\Local\Temp\p4v\FRWP1SASCHAH_perforce_1666\d

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  <AnimationList>
    <Animation name="#filepath" path="Animations/
    <Animation name="*" path="*.caf"/>
  </AnimationList>
</Params>
```

Animation Export

☑ Use object bones (Lock)

Animation range
● Entire timeline
○ Custom
from 0 to 100
○ Multiple custom ranges

□ Ignore Dummy bones

Geometry Export

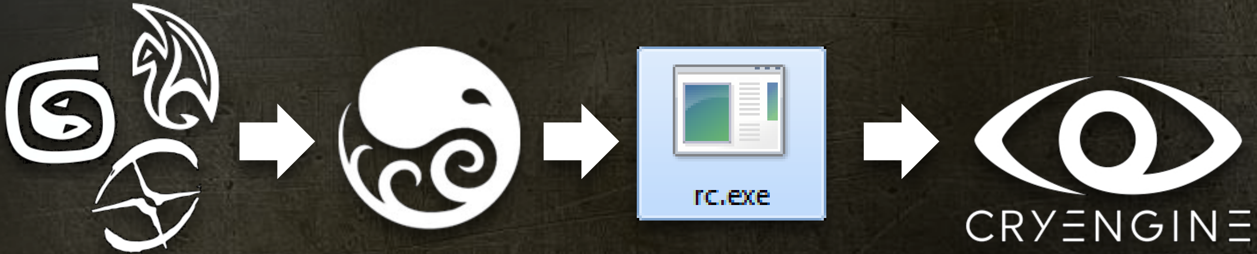
Export format: Geometry (*.cgf)

□ Export file per node
□ Custom filename:

□ Merge all nodes
☑ Vertex colors
□ Custom normals
□ Share mesh instances
Morph target pos. threshold 0,1
□ Vertex animation
Every 1 frame

Pipeline

GeomCaches – Pipeline



DCC App

- Model
- Rig
- Animate
- Export

[Video 02]

Alembic File

- Baked Result
- Goes into P4
- Lossless intermediate

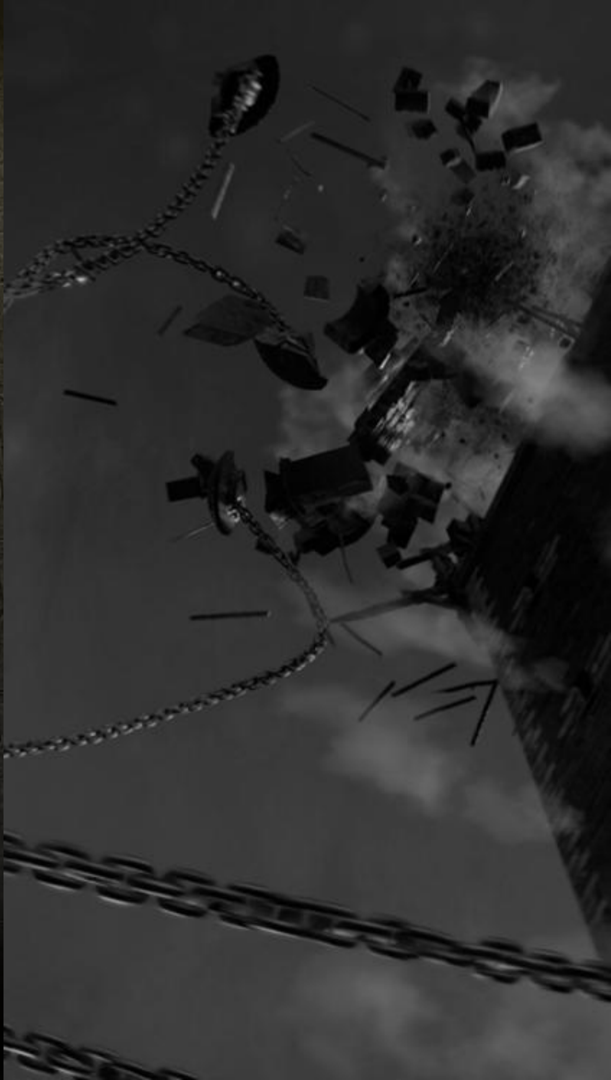
RC

- Validate
- Clean up
- Fix issues
- Compress
- Make Engine-ready File

CRYENGINE

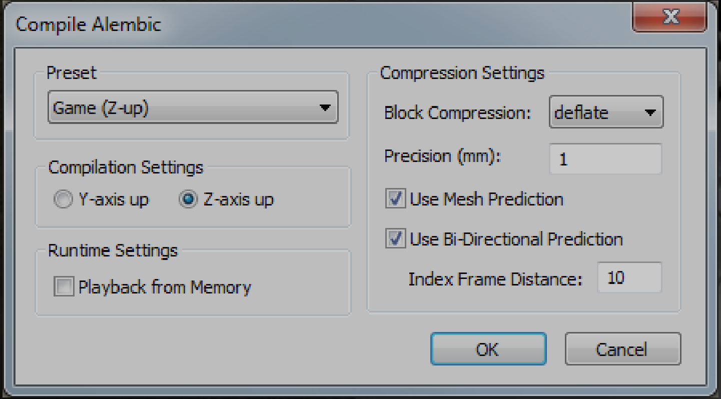
- Stream
- Animate
- Render

Features



GeomCaches – Features #1

- Imports vanilla Alembic Caches
  - Animated transform hierarchies
  - Homogeneous, deforming meshes
- User-friendly
  - No engine-markup (besides mat-ID)
  - Auto cleanup & optimization
  - Importer presets
- Additional data-streams
  - Tangent Frames
  - Visibility (i.e. fracturing)
  - Vertex Colors [Video 03]



Compile Alembic

Preset

Game (Z-up)

Compilation Settings

○ Y-axis up ● Z-axis up

Runtime Settings

□ Playback from Memory

Compression Settings

Block Compression: deflate

Precision (mm): 1

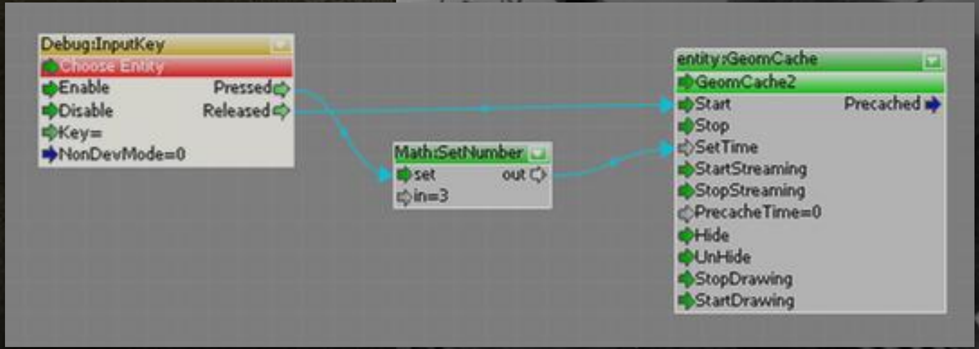
☑ Use Mesh Prediction

☑ Use Bi-Directional Prediction

Index Frame Distance: 10

GeomCaches – Features #2

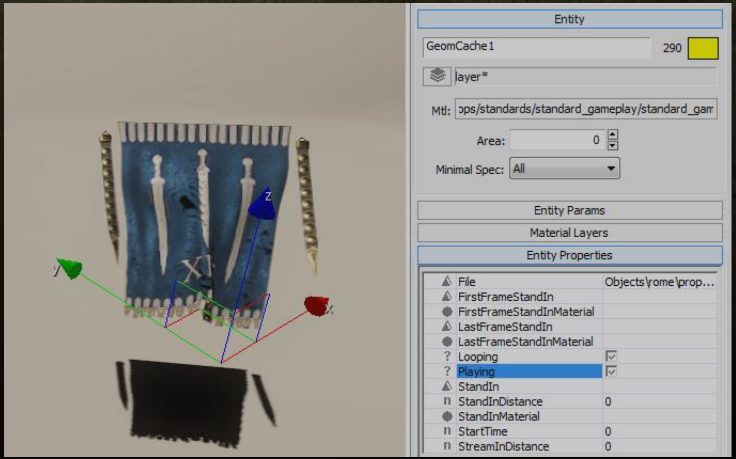
- Memory-friendly (7,5x avg. compression)
- Efficient Rendering [Video 04]
- Sandbox-esque [Video 05]
  - Flowgraph- & Trackview-integration



Debug:InputKey
Choose Entity
Enable
Disable
Key=
NonDevMode=0
Pressed
Released

Math:SetNumber
set
in=3
out

entity:GeomCache
GeomCache2
Start
Stop
SetTime
StartStreaming
StopStreaming
PrecacheTime=0
Hide
UnHide
StopDrawing
StartDrawing
Precached



Entity

GeomCache1 290

layer*

Mtl: ɔps/standards/standard_gameplay/standard_gam

Area: 0

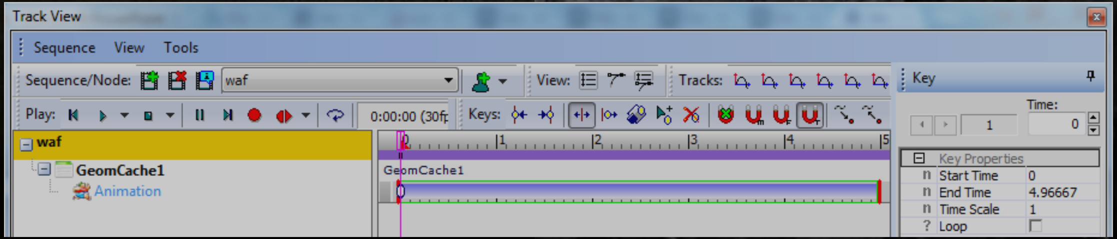
Minimal Spec: All

Entity Params

Material Layers

Entity Properties

File	Objects\rome\prop...
FirstFrameStandIn	
FirstFrameStandInMaterial	
LastFrameStandIn	
LastFrameStandInMaterial	
Looping	☑
Playing	☑
StandIn	
StandInDistance	0
StandInMaterial	
StartTime	0
StreamInDistance	0



Sequence/Node: waf

0:00:00 (30fp

waf
GeomCache1
Animation

GeomCache1

Key Properties

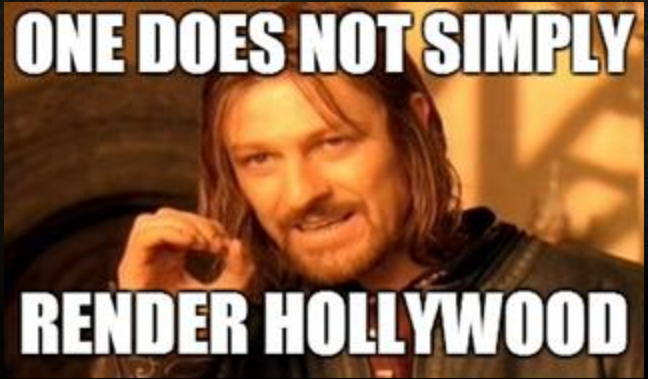
Start Time	0
End Time	4.96667
Time Scale	1
Loop	□

Limitations

GeomCaches – Limitations

Right?

Unfortunately…



GeomCaches – Limitations

- Many polygons are still expensive
  - Still need to create LODs
- Loading data is still slow
- No physics support (yet)
- Not all Alembic features supported
  - No heterogeneous meshes (i.e. particle fluid caches)
  - No SubD surfaces
  - No curves
- Can be used or abused
  - Requires experienced artists

Development

GeomCaches – Development

- Dedicated Engineer and Tech Artist
- Engineer:
  - Compression (RC)
  - Streaming System
  - Renderer Integration
  - Editor Integration
  - Build support
- Tech Artist:
  - Pipeline specs
  - VFX RnD
  - prototypical User
  - Tech Evangelist
  - VFX TD

GeomCaches – Development

- New team with little 'cinematic' experience
- Required lots of Research & Documentation
  - Keeps goals visible
  - Simplifies handoff (i.e. outsourcing)
  - Answers FAQs [Video 06]

CRYTEK Next Gen VFX Quality Reference

13 Added by Sascha Herfort, last edited by Sascha Herfort on Apr 25, 2012 (view change)

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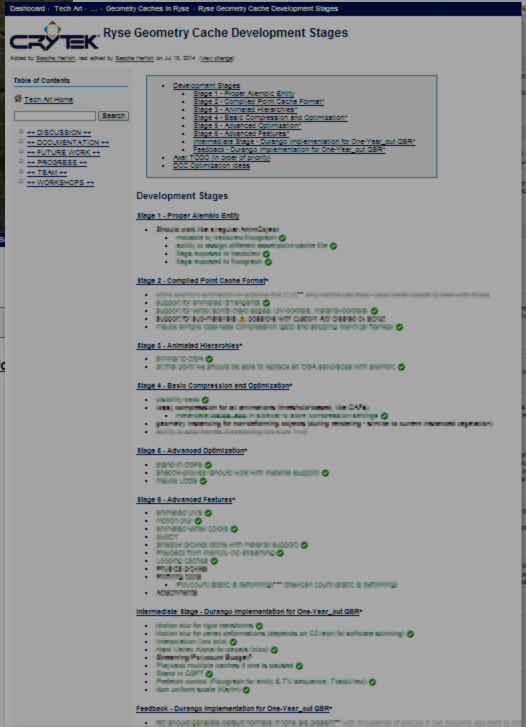
On this page, we collect videos and pictures of very high quality and aesthetic value VFX, to outline a quality benchmark for our VFX in upcoming games. Also negative examples of things that are accepted in current gen, but need to go for next are welcome.
Note: we're not necessarily looking for photo-realism only. Sometimes slight stylization can make an effect look much more tasteful.

Fluids	Video	Why it's Next Gen	Thumbnail
water crashing into ground	[illegible]	coherent motion, colliding w/ environment continuous stream with smooth surface beautiful shading (AO, SSS)	


Dashboard · Tech Art · ... · Geometry Caches in Ryse · Ryse Geometry Cache Development Stages

CRYTEK Ryse Geometry Cache Development Stages

Added by Sascha Herfort, last edited by Sascha Herfort on Jul 15, 2014 (view change)

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  - Stage 2 - Compiled Point Cache Format*
  - Stage 3 - Animated Hierarchies*
  - Stage 4 - Basic Compression and Optimization*
  - Stage 5 - Advanced Optimization*
  - Stage 6 - Advanced Features*
  - Intermediate Stage - Durango Implementation for One-Year_out QBR*
  - Feedback - Durango Implementation for One-Year_out QBR*
- Axel TODO (in order of priority)
- DOC Optimization Ideas

Development Stages

Stage 1 - Proper Alembic Entity

Stage 2 - Compiled Point Cache Format*

Stage 3 - Animated Hierarchies*

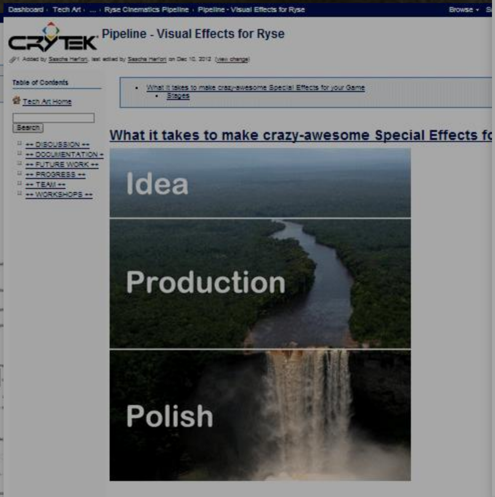
Stage 4 - Basic Compression and Optimization*

Stage 5 - Advanced Optimization*

Stage 6 - Advanced Features*

Intermediate Stage - Durango Implementation for One-Year_out QBR*

Feedback - Durango Implementation for One-Year_out QBR*


Dashboard · Tech Art · ... · Ryse Cinematics Pipeline · Pipeline - Visual Effects for Ryse

CRYTEK Pipeline - Visual Effects for Ryse

1 Added by Sascha Herfort, last edited by Sascha Herfort on Dec 10, 2012 (view change)

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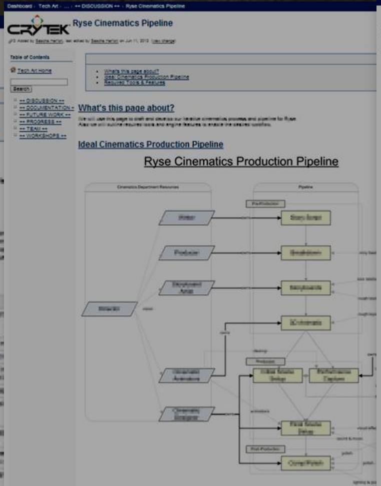
  - Stages

What it takes to make crazy-awesome Special Effects fo


Dashboard · Tech Art · ... · ++ DISCUSSION ++ · Ryse Cinematics Pipeline

CRYTEK Ryse Cinematics Pipeline

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- What's this page about?
- Ideal Cinematics Production Pipeline
- Required Tools & Features

What's this page about?

Ideal Cinematics Production Pipeline

Ryse Cinematics Production Pipeline

Dashboard · Tech Art · ... · Ryse Cinematics Pipeline · Geometry Caches in Ryse

CRYTEK Geometry Caches in Ryse

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- What's this page about?
- Overview
- Features & Details

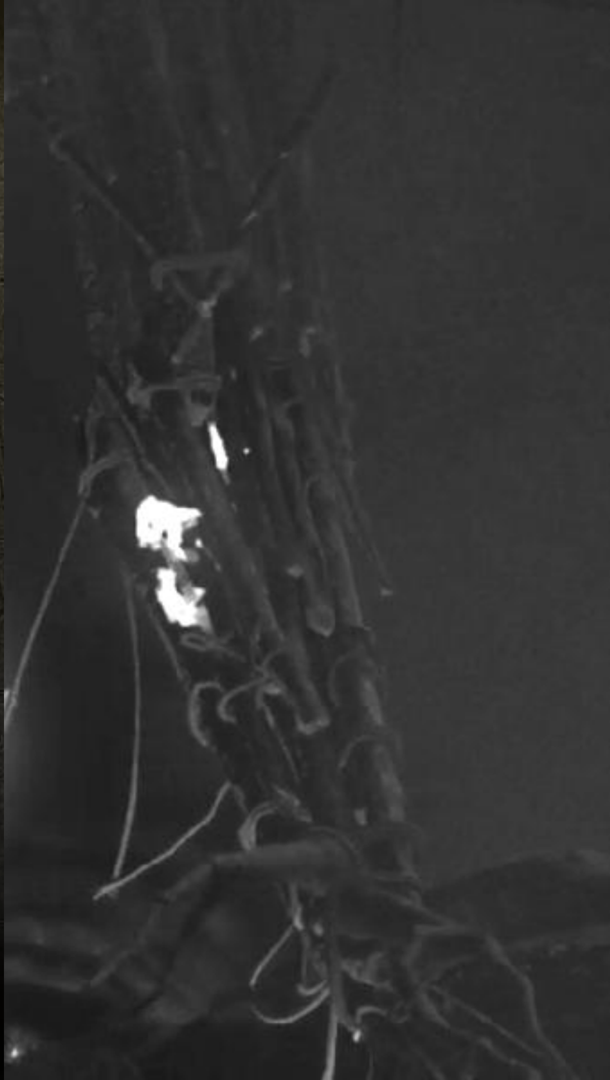
What's this page about?

Overview

Features & Details

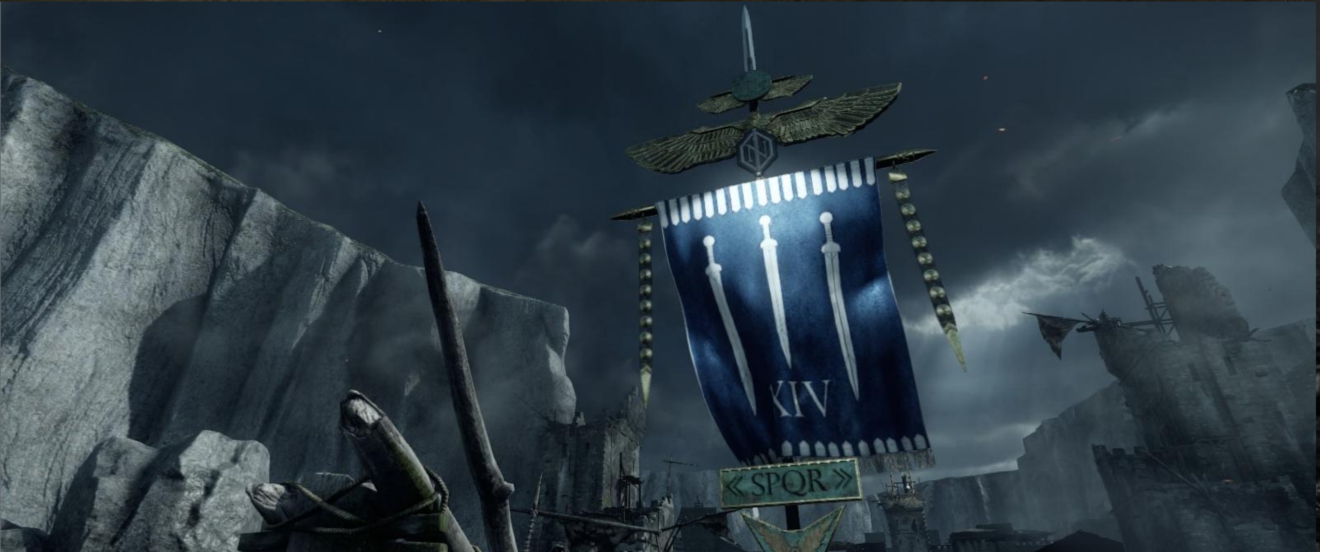
Prio	Feature	Description

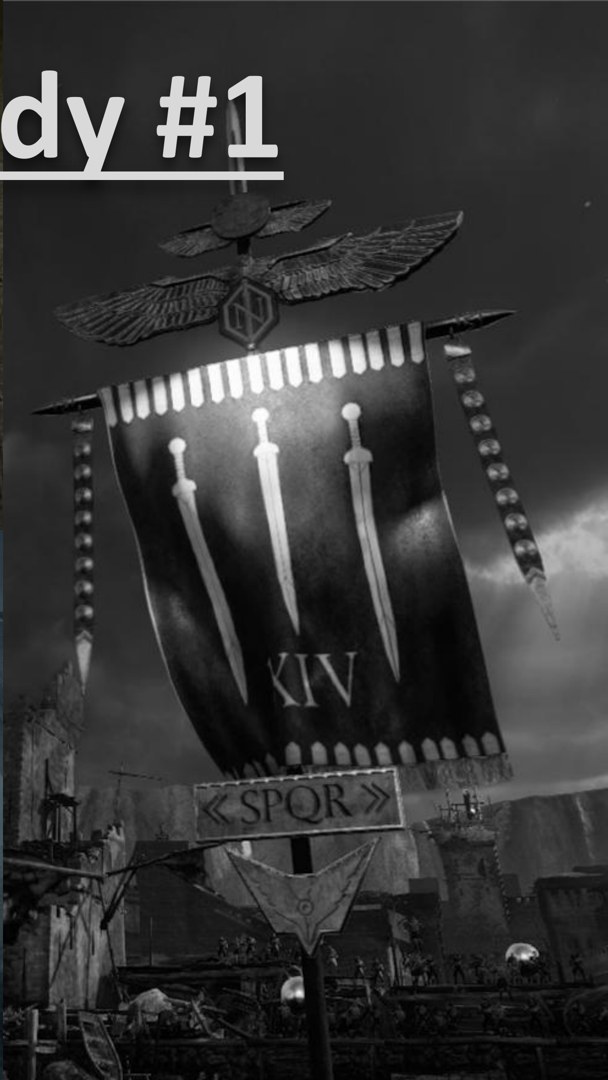
Case Studies



GeomCaches – Case Study #1

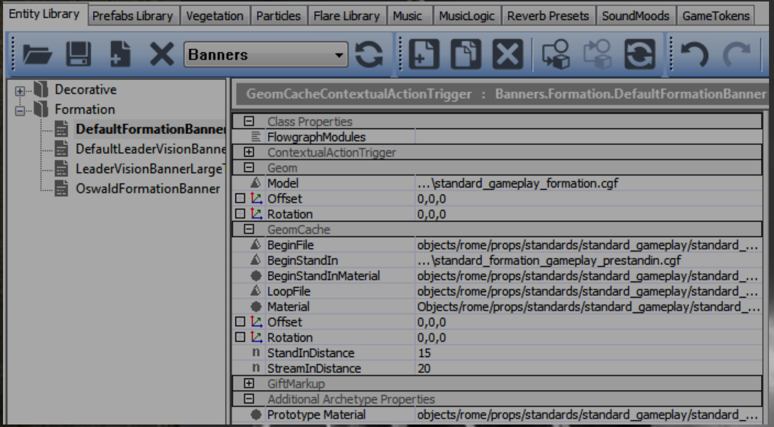
- Formation Banner [Video 07]
  - Marks contextual action for player
  - Must work in any environment (ignore wind etc.)
  - Complex cloth motion (unrolling, tassels)
- Cannot rely on real-time physics





GeomCaches – Case Study #1

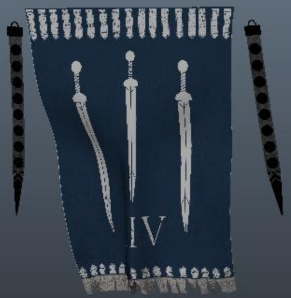
- Setup:
  - Special Entity wraps caches, LODs & logic
    - Game logic
    - Streaming
    - Animation (unrolling & looping)
    - LODing
  - Tech Artist creates asset & sets up prefab
  - Level Designers place it & works out of the box



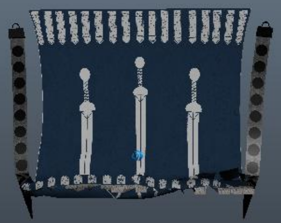
GeomCacheContextualActionTrigger : Banners.Formation.DefaultFormationBanner

⊟ Class Properties	
FlowgraphModules	
⊞ ContextualActionTrigger	
⊟ Geom	
Model	...\standard_gameplay_formation.cgf
□ Offset	0,0,0
□ Rotation	0,0,0
⊟ GeomCache	
BeginFile	objects/rome/props/standards/standard_gameplay/standard_...
BeginStandIn	...\standard_formation_gameplay_prestandin.cgf
BeginStandInMaterial	objects/rome/props/standards/standard_gameplay/standard_...
LoopFile	objects/rome/props/standards/standard_gameplay/standard_...
Material	Objects/rome/props/standards/standard_gameplay/standard_...
□ Offset	0,0,0
□ Rotation	0,0,0
StandInDistance	15
StreamInDistance	20
⊞ GiftMarkup	
⊟ Additional Archetype Properties	
Prototype Material	objects/rome/props/standards/standard_gameplay/standard_...

Looping Cache



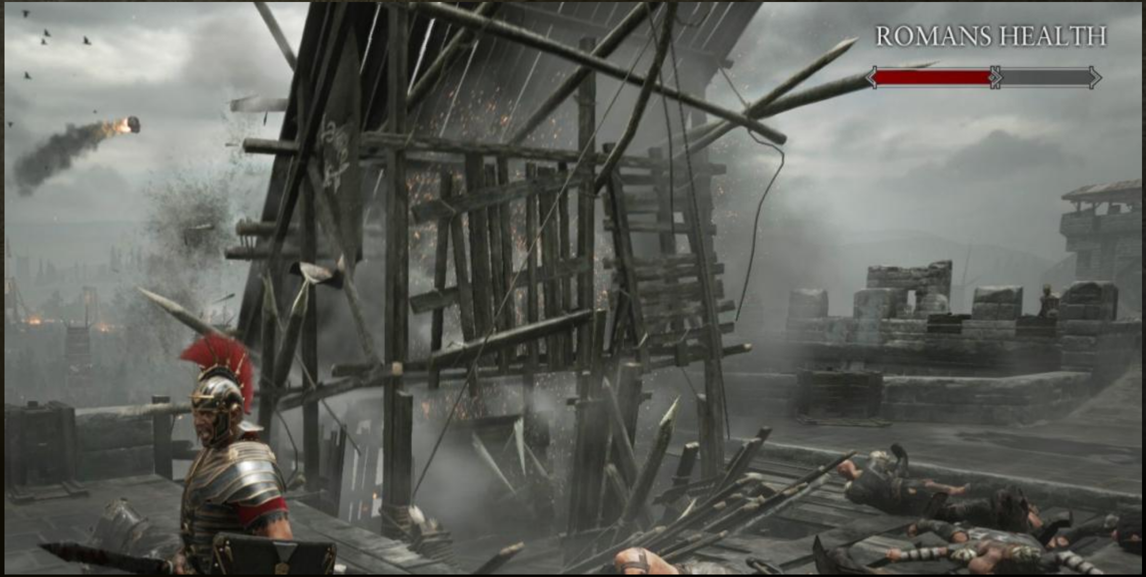
Unrolling Cache



Standin + LODs

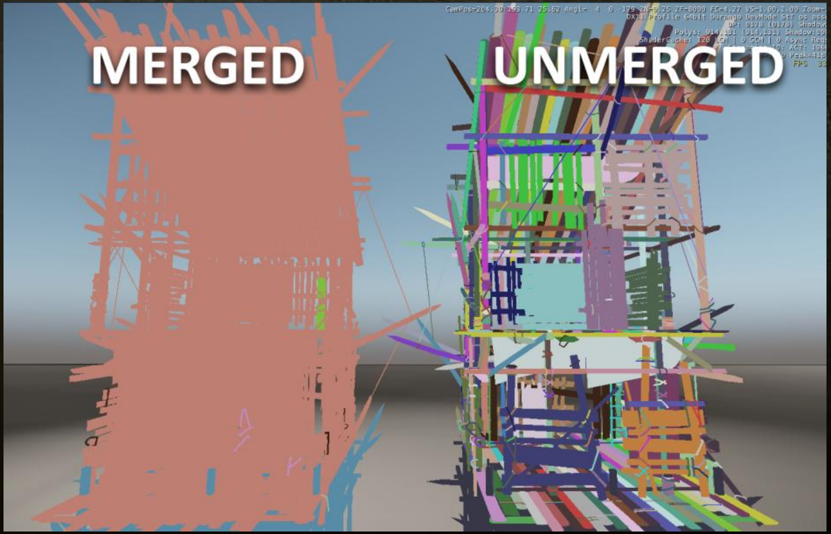
GeomCaches – Case Study #2

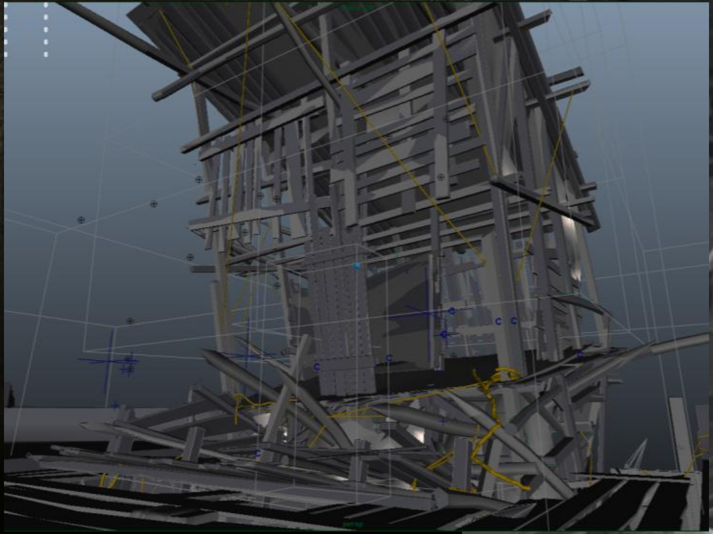
- Destructible Siege Tower [Video 08]
  - Wood, ropes, cloth
- Player attacks weak spots
- ~700 moving parts, 50 drawcalls

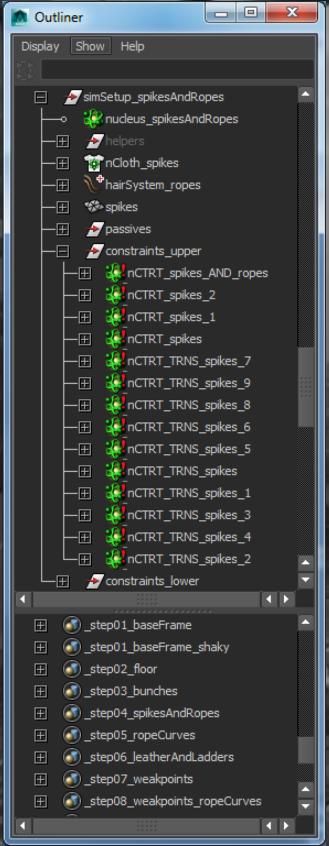


GeomCaches – Case Study #2

- Maya Setup:
  - nCloth & nHair
    - traditional RBD not suitable for scaffolding
    - nCloth rigids more stable & forgiving
  - 6 layers of simulation (large, small, cloth, ropes, …)
  - Result merged into deforming mesh





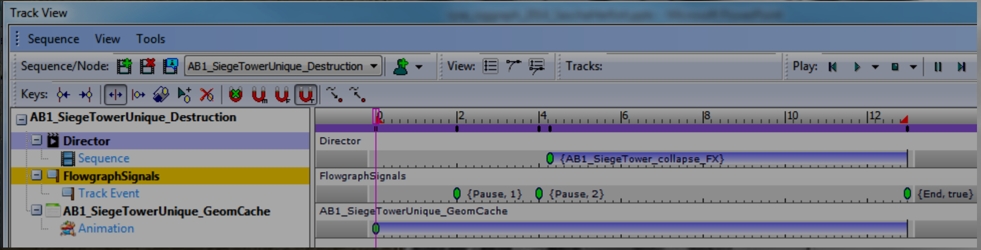


- simSetup_spikesAndRopes
  - nucleus_spikesAndRopes
  - helpers
  - nCloth_spikes
  - hairSystem_ropes
  - spikes
  - passives
  - constraints_upper
    - nCTRT_spikes_AND_ropes
    - nCTRT_spikes_2
    - nCTRT_spikes_1
    - nCTRT_spikes
    - nCTRT_TRNS_spikes_7
    - nCTRT_TRNS_spikes_9
    - nCTRT_TRNS_spikes_8
    - nCTRT_TRNS_spikes_6
    - nCTRT_TRNS_spikes_5
    - nCTRT_TRNS_spikes
    - nCTRT_TRNS_spikes_1
    - nCTRT_TRNS_spikes_3
    - nCTRT_TRNS_spikes_4
    - nCTRT_TRNS_spikes_2
  - constraints_lower

- _step01_baseFrame
- _step01_baseFrame_shaky
- _step02_floor
- _step03_bunches
- _step04_spikesAndRopes
- _step05_ropeCurves
- _step06_leatherAndLadders
- _step07_weakpoints
- _step08_weakpoints_ropeCurves

GeomCaches – Case Study #2

- Game Setup:
  - Separate cache per weak spot
  - Game logic starts/stops animation
  - Static LODs for distance



Track View

Sequence View Tools

Sequence/Node: AB1_SiegeTowerUnique_Destruction

View: Tracks: Play:

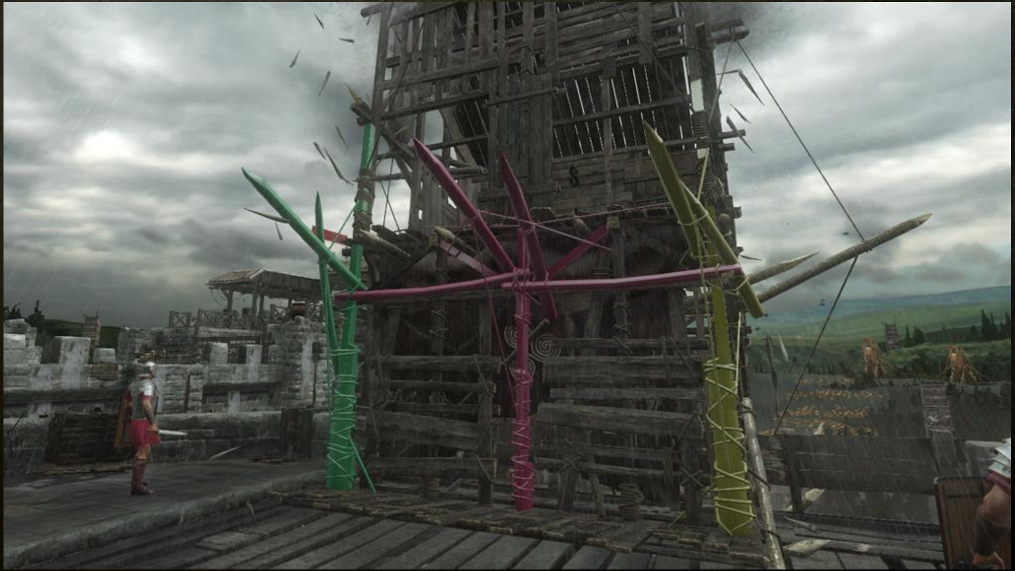
Keys:

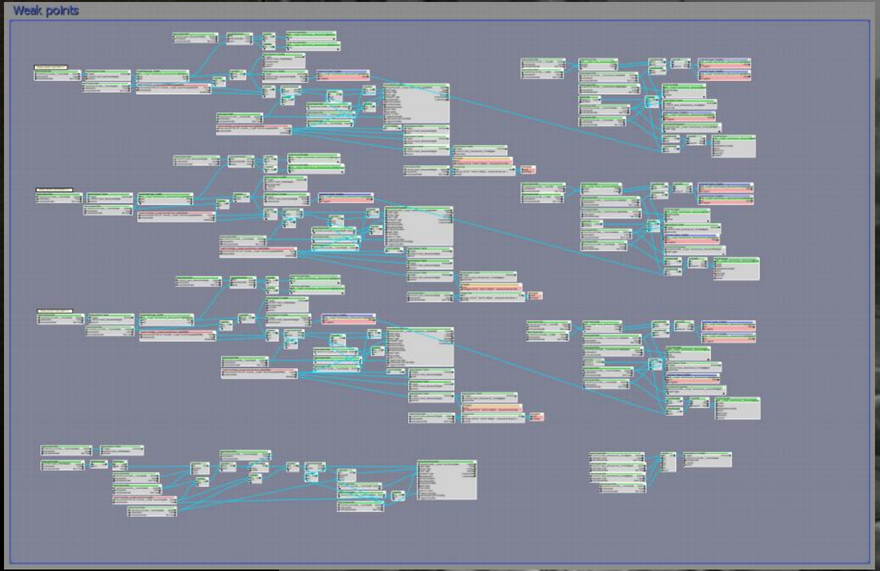
AB1_SiegeTowerUnique_Destruction
- Director
  - Sequence
- FlowgraphSignals
  - Track Event
- AB1_SiegeTowerUnique_GeomCache
  - Animation

Director
{AB1_SiegeTower_collapse_FX}

FlowgraphSignals
{Pause, 1} {Pause, 2} {End, true}

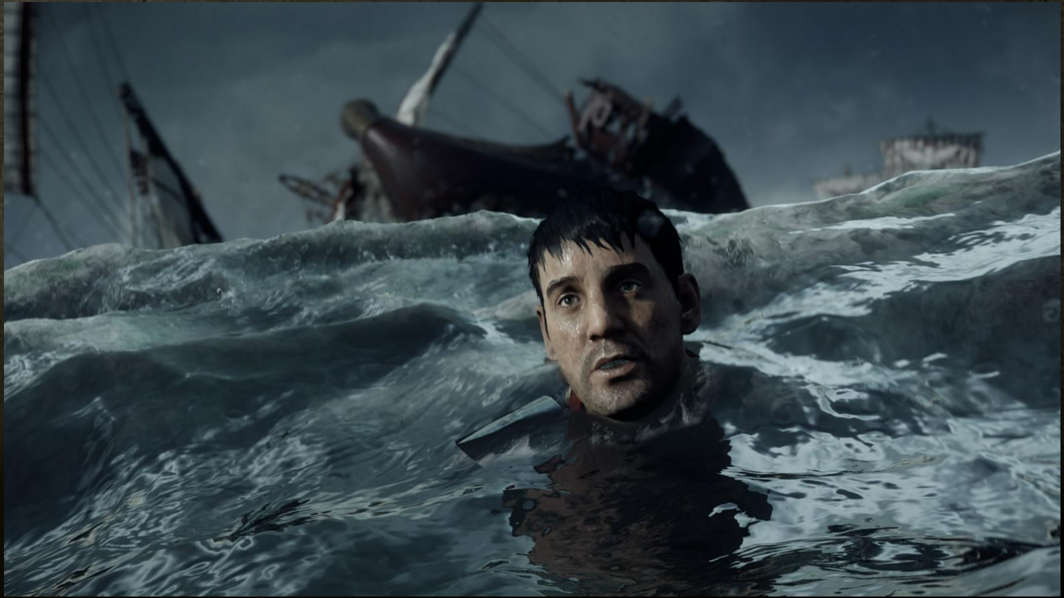
AB1_SiegeTowerUnique_GeomCache





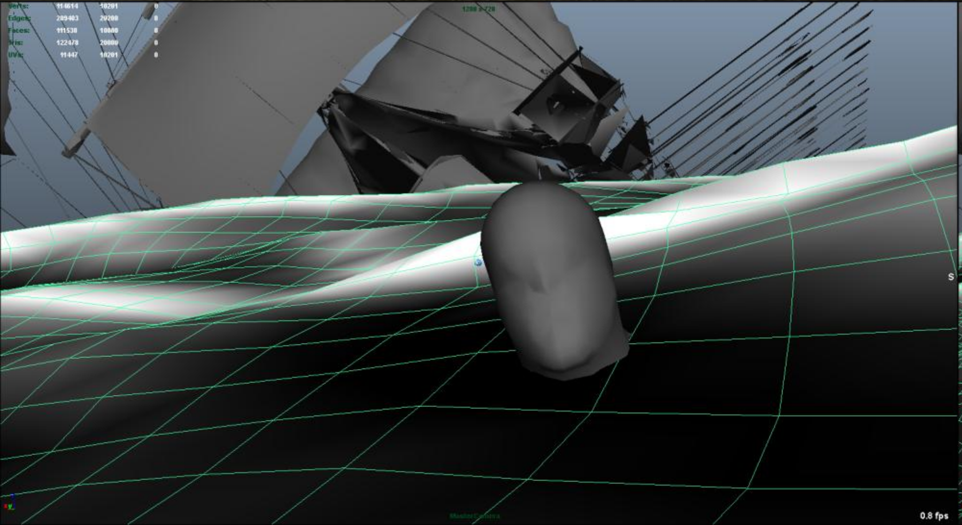
GeomCaches – Case Study #3

- Cinematic Ocean [Video 09]
  - Character swimming in it
  - Art-directed motion for camera angle
- Cannot use procedural in-engine ocean

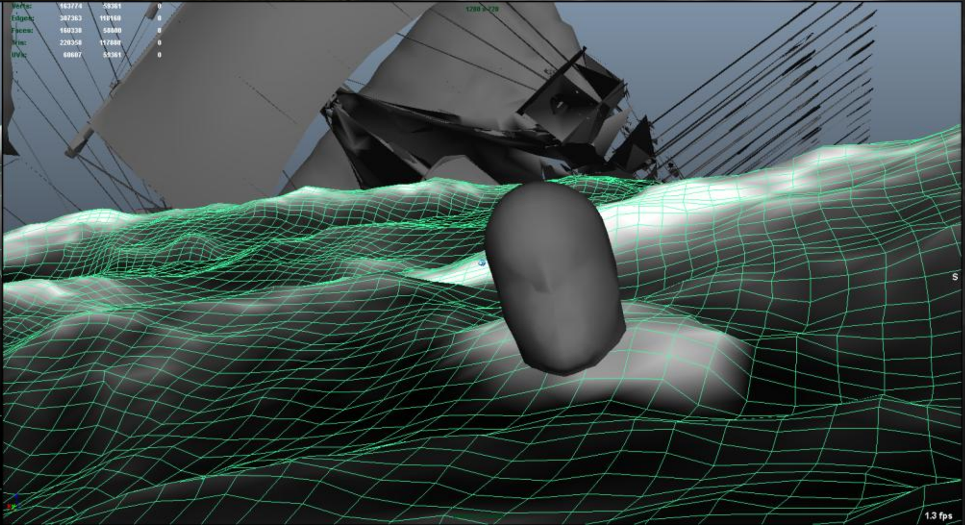


GeomCaches – Case Study #3

- Maya setup:
  - HOT Maya Plug-in (Tessendorf waves, multiple layers)
  - SOuP Maya Plug-in (per-vertex expressions sculpt waves)
  - 2d-fluid solver for character ripples
  - Character rig attached to ocean surface



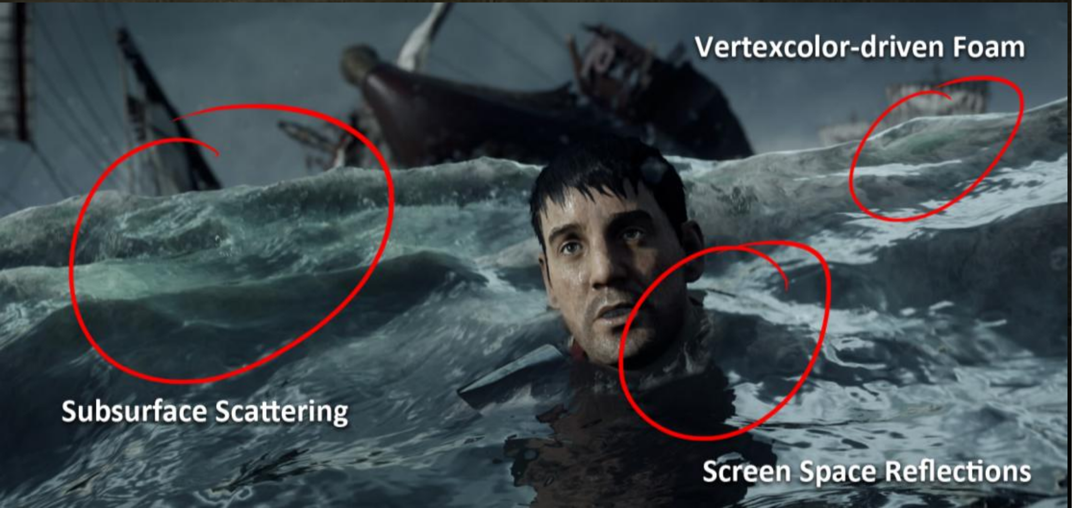
```
Verts:   114614   10201   0
Edges:   209403   20200   0
Faces:   111530   10000   0
Tris:    122478   20000   0
UVs:      11447   10201   0
```

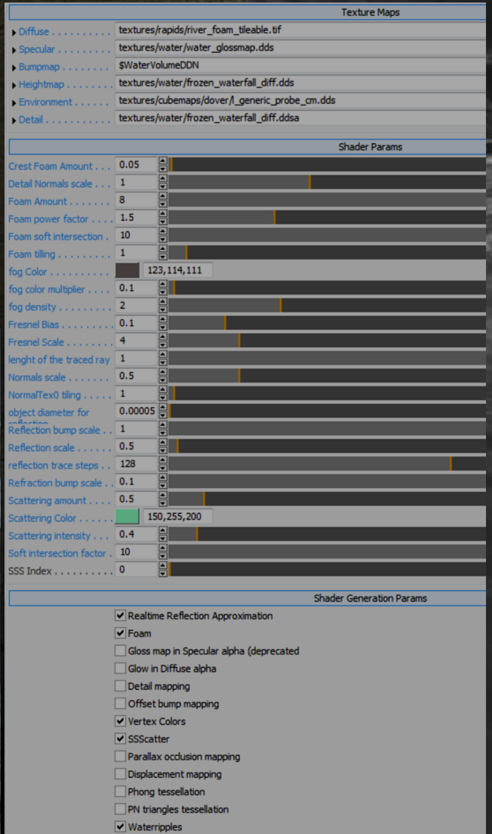


```
Verts:   163774   59361   0
Edges:   307363   118160  0
Faces:   160338   58800   0
Tris:    220358   117600  0
UVs:      60607   59361   0
```

GeomCaches – Case Study #3

- Custom Ocean Shader
  - Works on arbitrary geometry
  - Vertex colors drive foam & SSS
  - SSR for contact reflections
  - Procedural normal map & rain ripples





Texture Maps

Diffuse	textures/rapids/river_foam_tileable.tif
Specular	textures/water/water_glossmap.dds
Bumpmap	$WaterVolumeDDN
Heightmap	textures/water/frozen_waterfall_diff.dds
Environment	textures/cubemaps/dover/l_generic_probe_cm.dds
Detail	textures/water/frozen_waterfall_diff.ddsa

Shader Params

Crest Foam Amount	0.05
Detail Normals scale	1
Foam Amount	8
Foam power factor	1.5
Foam soft intersection	10
Foam tilling	1
fog Color	123,114,111
fog color multiplier	0.1
fog density	2
Fresnel Bias	0.1
Fresnel Scale	4
lenght of the traced ray	1
Normals scale	0.5
NormalTex0 tiling	1
object diameter for reflection	0.00005
Reflection bump scale	1
Reflection scale	0.5
reflection trace steps	128
Refraction bump scale	0.1
Scattering amount	0.5
Scattering Color	150,255,200
Scattering intensity	0.4
Soft intersection factor	10
SSS Index	0

Shader Generation Params

☑ Realtime Reflection Approximation
☑ Foam
□ Gloss map in Specular alpha (deprecated
□ Glow in Diffuse alpha
□ Detail mapping
□ Offset bump mapping
☑ Vertex Colors
☑ SSScatter
□ Parallax occlusion mapping
□ Displacement mapping
□ Phong tessellation
□ PN triangles tessellation
☑ Waterripples

GeomCaches – Case Study #4

- Character Cloth [Video 10]
  - 5 main characters
  - Complex costumes & hairstyles
  - Cannot setup/tweak before final animation
- GeomCaches: can polish/tweak every vertex

GeomCaches – Case Study #4

- 70+ animation clips
- 1-2 characters per rigging TA
  - Trained by VFX TD on GeomCaches
- Set poly limits early in production

Conclusion

GeomCaches – Conclusion #1

Ryse Production:

- 11 artists using GeomCaches autonomously
  - (at the end of production)
- 150+ cache files
- 1,5 hours cache content
  - 1 hour character cloth
  - 30 minutes bat-shit crazy destruction, oceans & sailboats
- 170+ GB Alembic

↳ 25,4 GB GeomCache

GeomCaches – Conclusion #2

Future Work:

- Physics
  - Passive proxies
  - Turn active on contact?
  - Blend cache & real-time sim?
- Heterogeneous Meshes?
  - DMM
  - Thinking Particles
  - Particle Fluids
- Cache Blending?
- CRYENGINE → Alembic Exporter

THANK YOU.

The Shout-Outs…

Alexander Raab

Atri Dave

Axel Gneiting

Bogdan Coroi

Chris Evans

Chris Mead

Dominik Butnaru

Eric Werner

Fabio Silva

Jeffery Khou

Joseph Garth

Michael Kopietz

Nicolas Schulz

Riham Toulan

Thomas Franta

Travis Ramsdale

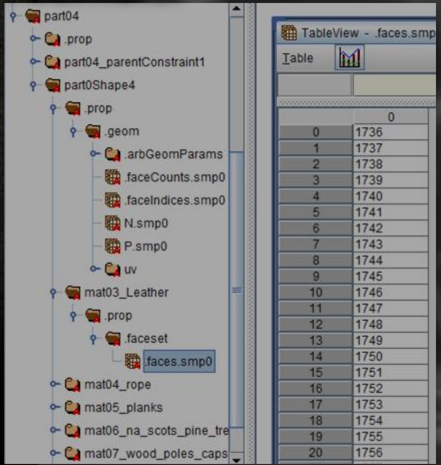
…and everybody at Crytek!

Bonus Slides

GeomCaches – Bonus Slide #1

- The ugly part of the pipeline: **Material Order**
- The Problem:
  - *“Which material does this polygon use?”*
  - Every 3D-package does this differently
  - CRYENGINE requires material-IDs per face
- Our solution:
  - Alembic has *“face sets”*
  - Generated by script before export
  - Mat-ID = first integer found in face set name

Alembic:



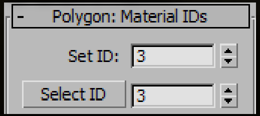
```
part04
  .prop
  part04_parentConstraint1
  part0Shape4
    .prop
      .geom
        .arbGeomParams
        .faceCounts.smp0
        .faceIndices.smp0
        N.smp0
        P.smp0
        uv
    mat03_Leather
      .prop
        .faceset
          .faces.smp0
    mat04_rope
    mat05_planks
    mat06_na_scots_pine_tre
    mat07_wood_poles_caps
```

TableView - .faces.smp

Table

	0
0	1736
1	1737
2	1738
3	1739
4	1740
5	1741
6	1742
7	1743
8	1744
9	1745
10	1746
11	1747
12	1748
13	1749
14	1750
15	1751
16	1752
17	1753
18	1754
19	1755
20	1756

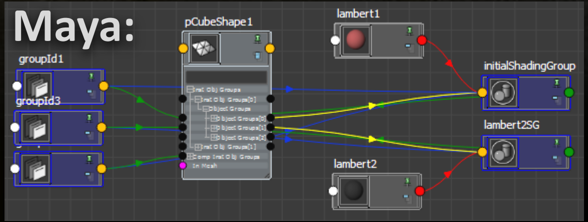
3dsMax:



- Polygon: Material IDs

Set ID: 3

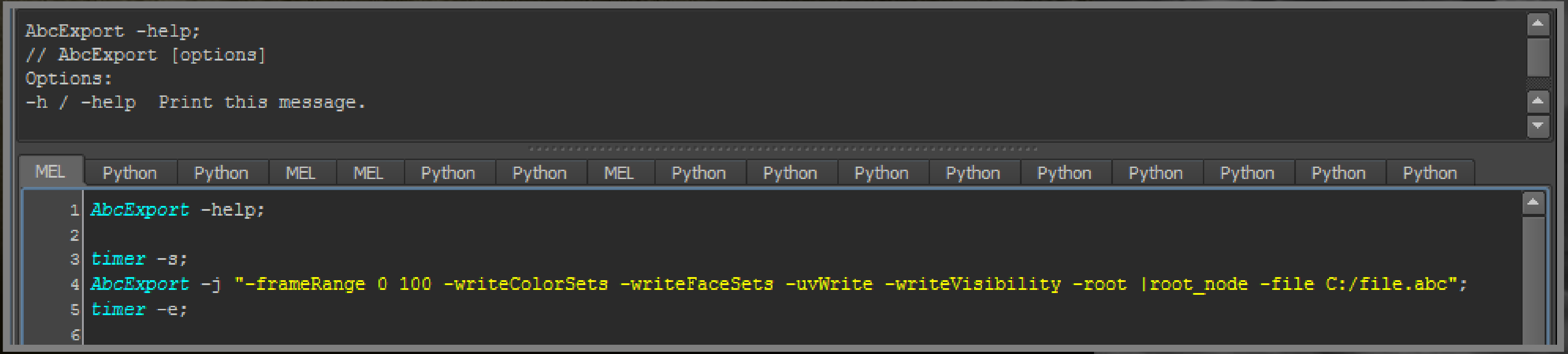
Select ID 3



Maya:

GeomCaches – Bonus Slide #2

- Maya 2014 Alembic export tricks:
  - MEL command has more features than exporter dialogue!
  - “-writeColorSets” exports vertex colors
  - “-writeFaceSets” exports face-sets
  - Learn more, using “AbcExport –help;”



```
AbcExport -help;
// AbcExport [options]
Options:
-h / -help  Print this message.
```

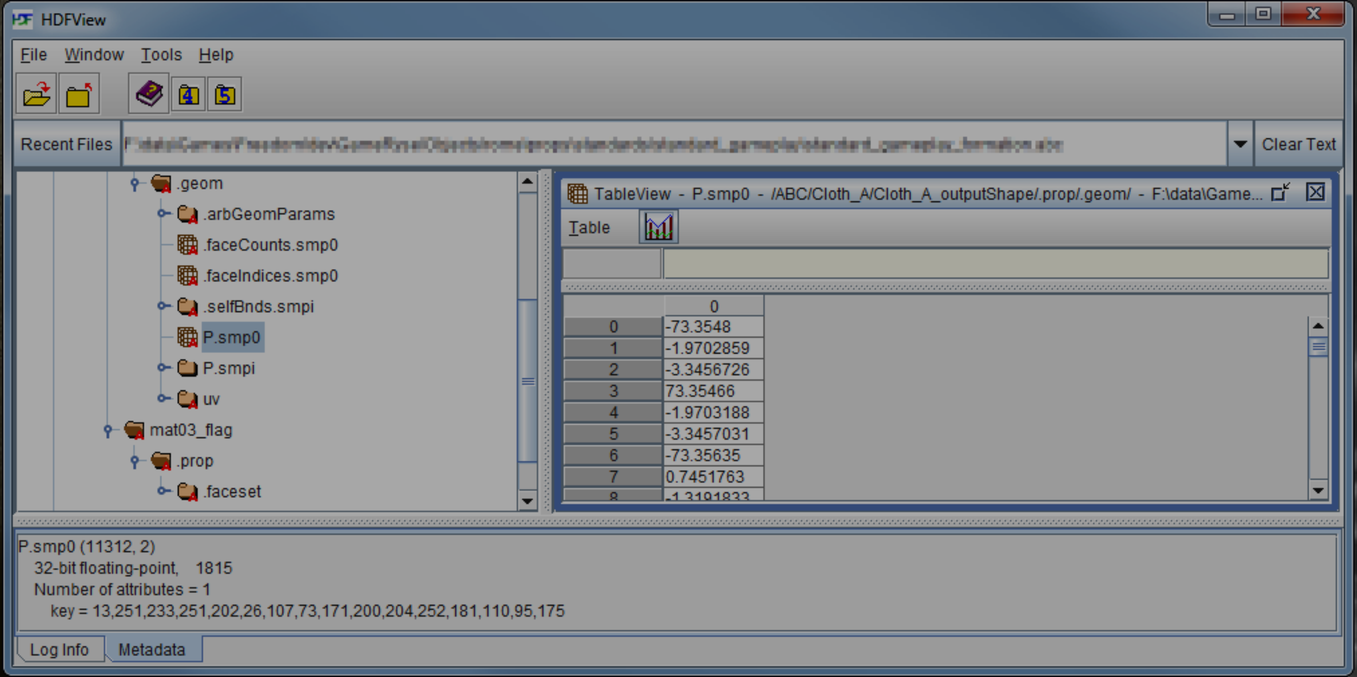
```
AbcExport -help;

timer -s;
AbcExport -j "-frameRange 0 100 -writeColorSets -writeFaceSets -uvWrite -writeVisibility -root |root_node -file C:/file.abc";
timer -e;

```

GeomCaches – Bonus Slide #3

- Debug old Alembic files with HDFView:
- [http://www.hdfgroup.org/products/java/hdfview/]



TableView - P.smp0 - /ABC/Cloth_A/Cloth_A_outputShape/.prop/.geom/ - F:\data\Game...

	0
0	-73.3548
1	-1.9702859
2	-3.3456726
3	73.35466
4	-1.9703188
5	-3.3457031
6	-73.35635
7	0.7451763
8	-1.3191833

```
P.smp0 (11312, 2)
  32-bit floating-point,    1815
  Number of attributes = 1
    key = 13,251,233,251,202,26,107,73,171,200,204,252,181,110,95,175
```